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PATENT SPECIFICATION

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DRAWINGS ATTACHED

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(54) GALVANIC STORAGE UNITS

(71) We, DEUTSCHE AUTOMOBILGESELLSCHAFT MIT BESCHRÄNKTER HAFTUNG, of 136, Mercedesstrasse, Stuttgart 60 (Unterturkheim), Germany, a Company organised under the laws of Germany, do hereby declare the invention, for which we pray that a patent may be granted to us and the method by which it is to be performed, to be particularly described in and by the following statement:—

The invention relates to a galvanic storage unit, more particularly, but not exclusively, for traction purposes and having in a common housing an accumulator device which is capable of providing relatively high currents for short periods, and a fuel cell device connected in parallel therewith. Galvanic systems have become known—e.g. the lead accumulator—which are capable of reversibly delivering electrical energy and storing it again in the form of chemical energy. Energy values referred to mass or to volume of 40 Wh/kg or 90 Wh/dm³ can be obtained with such systems if it is not desired to adopt systems involving very expensive materials such as for example are used in the Ag/Zn accumulator. However, accumulators of this type are not suitable for industrial application in the traction field.

It has been proposed to replace the negative electrode in a conventional accumulator —e.g. by a Raney nickel electrode (German Patent Specification No. 1,118,843) or a titanium hydride electrode. These electrodes are suitable for storing the active material (in this case hydrogen) with a higher charge density than is customarily the case with negative electrodes. Moreover, further electrochemical advantages result from this due to the fact that the electrochemically active material does not have to be built up in the form of a crystallographic lattice during deposition (i.e. during the charging process). When such a negative electrode is used, an accumulator having substantially more favourable energy values for traction is obtained, e.g.:—

Lead accumulator	=35 Wh/kg
Ni/Cd accumulator	=40 Wh/kg
$TiH_x/NiO(OH)_2$ accumulator	=70 Wh/kg

The fact that only a value of 70 Wh/kg can be realised for this accumulator, despite the high energy to mass ratio of the negative electrode which is 400 Wh/kg, is due to the fact that the positive electrode exhibits values of only approximately 100 Wh/kg.

One might possibly consider using the air electrode known from fuel cell technique instead of the positive electrode here. Since it does not work as a storage electrode, but utilises the surrounding atmosphere as an oxygen storage unit, it naturally exhibits a high charge to mass ratio.

It would therefore be possible to achieve values of 140 Wh/kg for a cell or battery. The disadvantage of such an arrangement is that due to the limited load capacity of the air electrode—particularly if the noble metals are not used as catalysts for reasons of economy —the power density (W/cm²) of the electrodes is small. Thus the following comparative values are obtained:—

Lead accumulator	0.03 . . 0.1 W/cm²
$TiH_x/NiO(OH)_2$ accumulator	0.05 . . 0.14 W/cm²
TiH_x/air cell	0.04 . . 0.06 W/cm²

Considering now the application to traction, where high power outputs are required for peak loads such as at starting, it becomes necessary for a TiH_x/air battery—also described hereinafter as an example of a fuel cell device—to be combined with an accumulator which is charged continuously by the battery and which supplements the battery to provide the high power outputs. This causes the initially advantageous energy to weight ratio to be seriously impaired.

It is the aim of the invention to provide a galvanic storage unit which is capable of delivering the currents required for the permanent load and also for the peak loads, and which at the same time permits surprisingly

[Price 25p]

It is clear from the table that the galvanic cell according to the invention is definitely superior for the range from 0 to 20% overload which is relevant to traction purposes. Also taking into account the fact that the construction of air electrodes is technically more complicated and expensive than the manufacture of accumulators, and that the data stated is valid for a TiH_x/air cell at a temperature of 80°C, whereas the data for the cell according to the invention is also valid for 0—20°C., the technical advantage of the latter becomes obvious.

A second embodiment of the invention is illustrated schematically in Figure 4 and comprises a double fuel cell and accumulator system with the two fuel cell devices arranged in mirror image symmetry on either side of a common positive electrode for the two accumulator devices. In a polysulphone frame 21, which consists of glued layers, are two spaced sets of polysulphone bars 22, each of which supports an air electrode 18 on one side. Such an air electrode may be 1 mm thick and have an area of 300 cm^2. Against each air electrode is an asbestos layer 17 as separator with a thickness of 0.5 mm. Against the separator in each case is an electrode 16 of TiH_x which is 1.5 mm thick and which constitutes a reversible negative electrode common to the adjacent fuel cell and accumulator devices. This in turn is followed in each case by an electrolyte space 23 in the case of the left hand assembly and electrolyte space 24 in the case of the right hand assembly, the two spaces 23 and 24 being mutually separated by positive electrode 14, which consists of $NiO(OH)_2$ and is 1 mm thick and constitutes a common positive electrode for the two accumulator devices. An air inlet channel 26 with tap pipes 27, through which air can be passed to the air electrodes 18, is shown at the top of Figure 4. A corresponding air outlet, not shown, is also provided.

In corresponding manner, an electrolyte inlet channel 28 with tap pipes 29 is provided through which electrolyte can be supplied to the electrolyte spaces 23, 24. A corresponding electrolyte outlet (not shown) is also provided. A gas space 31, which is 1 mm wide is present between the polysulphone bars 22.

Air/carbon electrodes as described by R. G. Haldemann in the last paragraph at page 5 of the prospectus of the Cyanamid Corporation of June, 1967, may be used for the air electrodes 18. Asbestos may be used as separator. The bars 22 may also be made of material sold under the name Teflon (Registered Trade Mark); they are 4—5 mm wide and act as supports and also for gas distribution in the gas space 31.

The electrode 14 may be a porous sintered nickel element, having been impregnated with active $NiO(OH)_2$.

By virtue of the favourable energy and power to weight ratio, the galvanic storage unit described is particularly suitable for traction purposes.

WHAT WE CLAIM IS:—

1. A galvanic storage unit having in common housing an accumulator for delivering relatively high currents for short periods and a fuel cell connected in parallel therewith, wherein the accumulator and the fuel cell have a common reversible negative electrode.
2. A storage unit according to claim 1, wherein a porous separator is provided between said common electrode and the positive electrode of the fuel cell which separates the two electrodes electrically but connects them mechanically together.
3. A storage unit according to claim 1 or 2 and comprising a double fuel cell and accumulator system, wherein the two fuel cell devices are arranged in mirror image symmetry on either side of a common positive electrode for the two accumulator devices.
4. A storage unit according to any one of claims 1 to 3, wherein the common negative electrode is a hydrogen electrode.
5. A storage unit substantially as hereinbefore described with reference to and as shown in Figures 1 to 3 or Figure 4 of the accompanying drawings.

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3 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 1

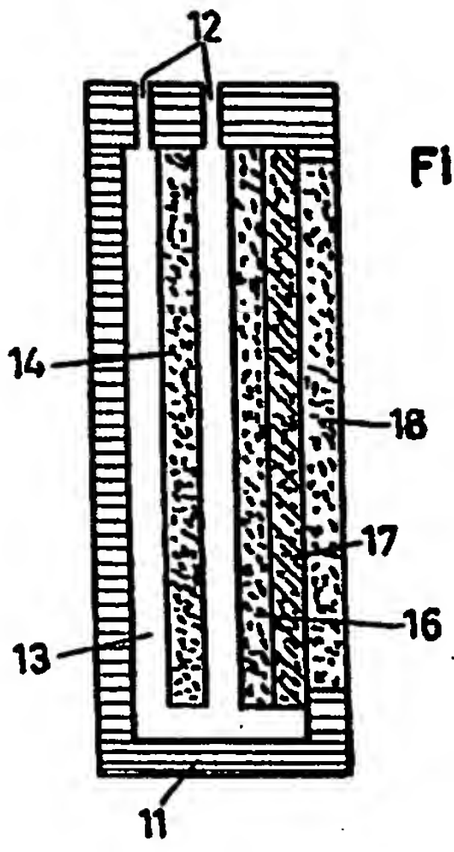

Fig.1

Fig.2

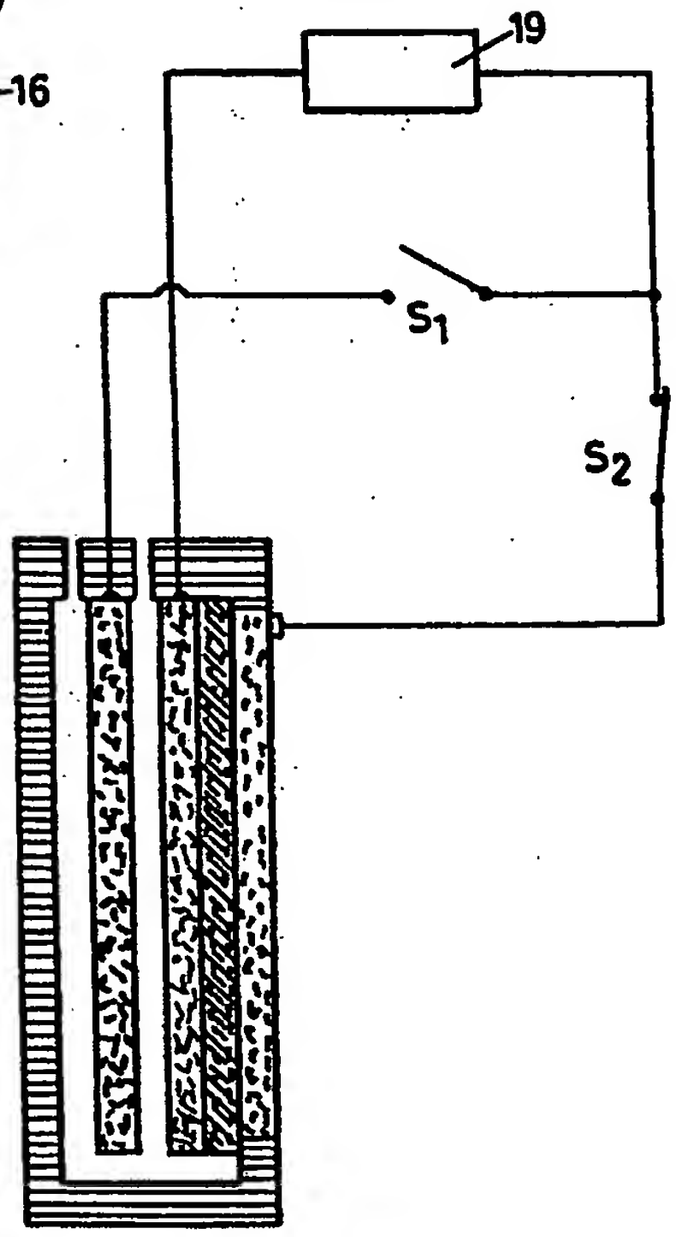

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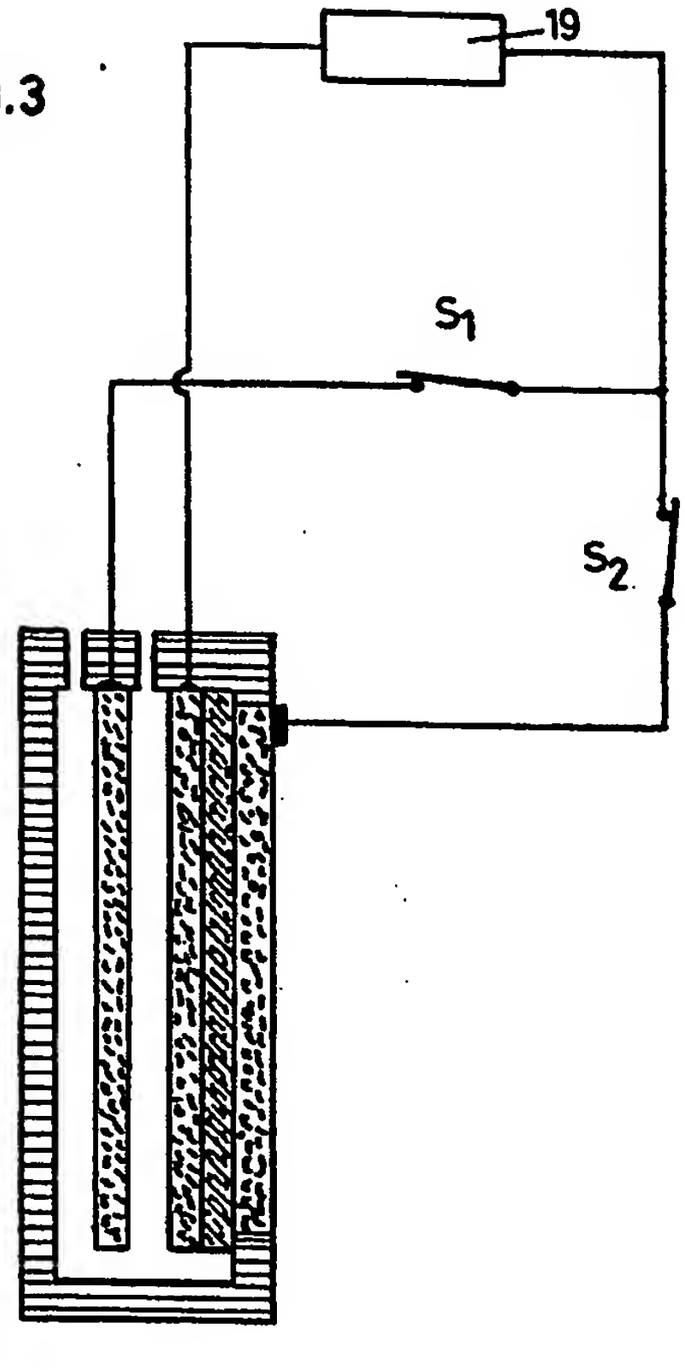
Fig.3



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Sheet 3

Fig.4